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(54) **AIR CONDITIONING SYSTEM FOR VEHICLE**

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B60H 1/32 (2006.01)

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(58) **Field of Classification Search**
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USPC 62/238.7
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(57) **ABSTRACT**

An air conditioner for a vehicle includes a cooler including a first radiator, a cooling fan sending air flow to the first radiator, a reservoir tank connected with the first radiator to store a cooling fluid, and a water pump circulating the cooling fluid. A water-cooled condenser is connected with the cooling line to condense superheated steam and a two-phase refrigerant, which includes gas and liquid, by heat exchange with the cooling fluid. An air-cooled condenser is connected with the water-cooled condenser through a refrigerant line in series to condense the refrigerant by heat exchanging with external air as the vehicle travels and to discharge the condensed refrigerant to a receiver drier.

5 Claims, 4 Drawing Sheets

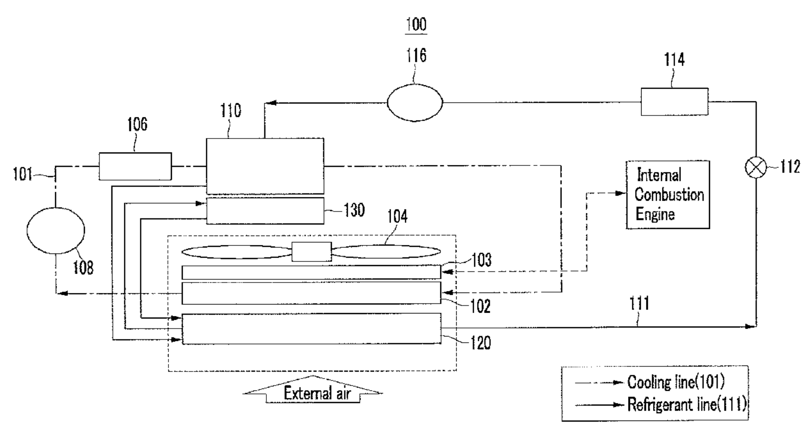

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FIG. 1

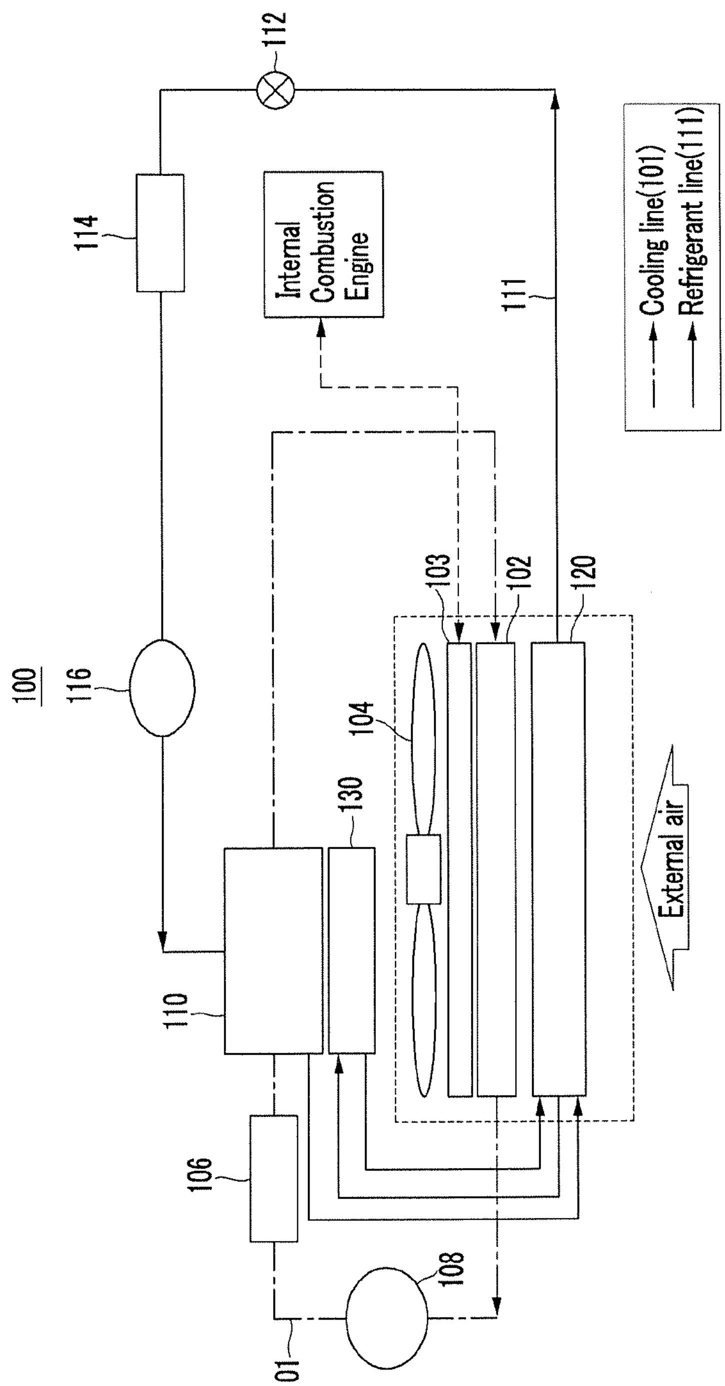
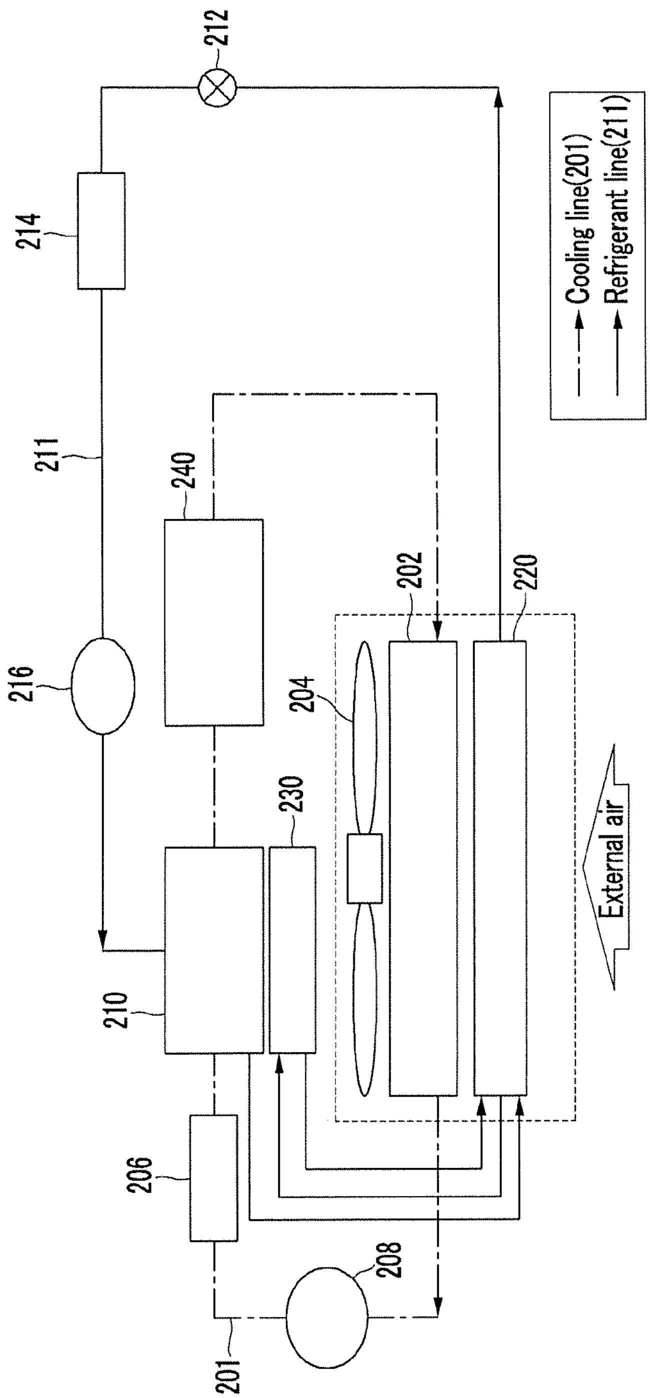

100
112
114
Internal Combustion Engine
111
Cooling line(101)
Refrigerant line(111)
103
102
120
116
104
130
External air
110
106
108
101

FIG. 2

200



212
214
211
240
216
202
220
204
230
210
206
208
201
Cooling line(201)
Refrigerant line(211)
External air

FIG. 3

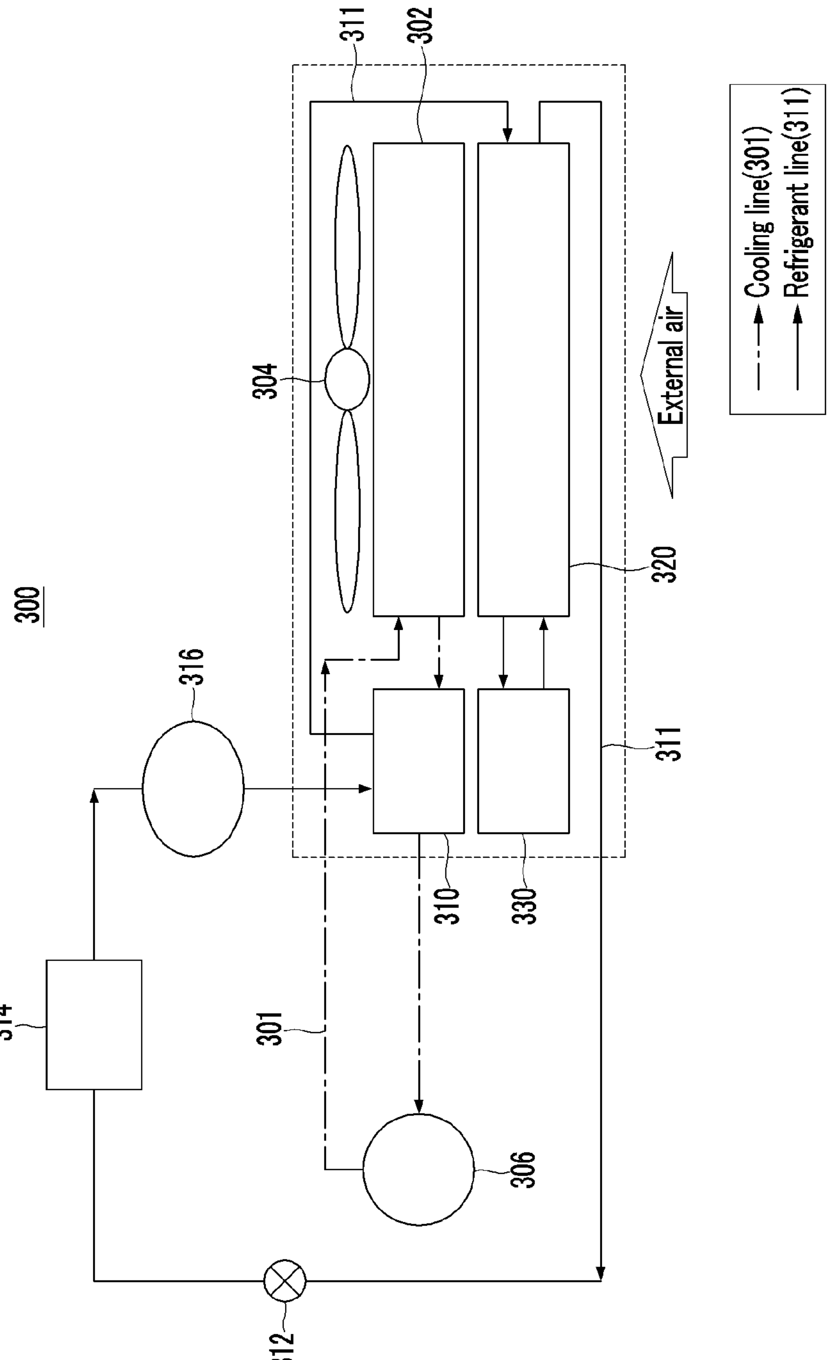
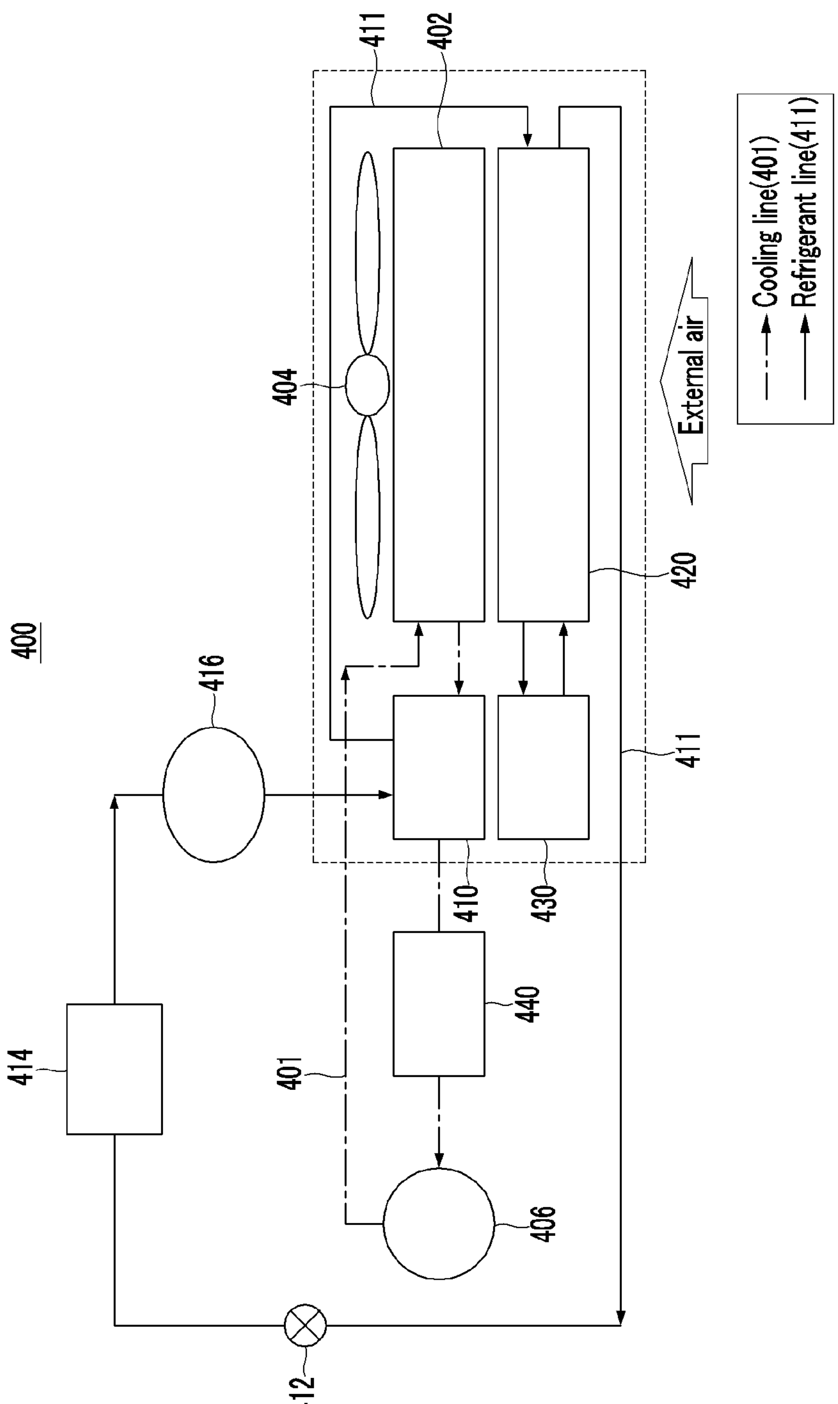

300
311
302
304
320
316
310
330
314
301
306
312
External air
Cooling line(301)
Refrigerant line(311)

FIG. 4


400
411
402
404
420
411
416
410
430
440
414
401
406
412
External air
Cooling line(401)
Refrigerant line(411)

AIR CONDITIONING SYSTEM FOR VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2013-0126238 filed in the Korean Intellectual Property Office on Nov. 8, 2012, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to an air conditioner for a vehicle, and more particularly, to an air conditioner for a vehicle, which improves overall cooling performance by increasing a condensation rate of a refrigerant by applying a water-cooled type condenser using a cooling fluid and an air-cooled type condenser using external air together when the refrigerant is condensed.

BACKGROUND

In general, an air conditioner of a vehicle maintains pleasant indoor environment by maintaining indoor temperature of the vehicle at an appropriate temperature regardless of outside temperature.

The air conditioner of the vehicle includes a compressor for compressing a refrigerant, a condenser for condensing and liquefying the refrigerant compressed by the compressor, and an expansion valve for rapidly expanding the refrigerant condensed and liquefied by the condenser. An evaporator disposed to cool air blown into the vehicle in which the air conditioner is installed by using evaporation latent heat of the refrigerant while evaporating the refrigerant expanded by the expansion valve.

According to the related art, when a water cooling type condenser is applied for condensing the refrigerant by cooling, the coolant exchanges heat with the refrigerant in the condenser. However, power consumption is increased due to a temperature increase of the refrigerant at an outlet of the condenser.

Since the water cooling type condenser has larger thermal capacity of a coolant than that of the air cooling type condenser, condensation pressure thereof is low. However, the temperature difference between coolant and refrigerant is small and the temperature of the coolant is higher than that of external air, such that sub cool is difficult to be formed, thereby degrading general cooling performance of the air conditioner.

Further, the amount of condensation of the coolant in an environmentally-friendly vehicle to which a motor, an electric power component, a stack, and the like are applied decreases because the coolant cools each constituent element and flows into a condenser, thus increasing coolant temperature.

To address the above drawbacks, a need exists for a cooling pan and a radiator with large capacity, but creating narrow engine room and increasing weight and manufacturing cost of a vehicle.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the disclosure, and therefore, it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

The present disclosure provides an air conditioner for a vehicle to improve cooling performance by reducing condensation pressure and increasing condensation performance of a refrigerant by employing a water cooling type condenser using coolant and an air cooling type condenser using external air together when the refrigerant is condensed.

An air conditioner system for a vehicle according to an exemplary embodiment of the present invention includes a cooling means including a radiator disposed at front side of a vehicle, a cooling fan configured to send wind to the radiator, a reservoir tank connected with the radiator through a cooling line to store cooling fluid, and a water pump disposed on the cooling line to circulate the cooling fluid. A water cooling type condenser is connected with the cooling line between the radiator and the reservoir tank into which the cooling fluid flows, and condenses a two-phase refrigerant, in which a superheated steam refrigerant, gas, and liquid are mixed from a compressor of an air conditioner means, through heat exchange with the cooling fluid. An air cooling type condenser is connected with the water cooling type condenser through a refrigerant line in series, into which the condensed refrigerant flows from the water cooling type condenser, disposed at front side of the radiator to condense the refrigerant through heat exchange with external air flowing in while driving and to discharge the condensed refrigerant to a receiver drier. The air cooling type condenser receives only a liquid refrigerant from which a gas refrigerant is separated while passing through the receiver drier to additionally condense the received liquid refrigerant through heat exchange with external air and to discharge the condensed refrigerant to an expansion valve.

The air conditioner means may include an expansion valve for expanding the condensed refrigerant, an evaporator for evaporating the expanded refrigerant through heat exchange with air, and the compressor for compressing the evaporated gas state refrigerant, which are connected with each other through the refrigerant line. The air conditioner means may condense the compressed refrigerant discharged from the compressor by making the discharged refrigerant sequentially pass through the water cooling type condenser and the air cooling type condenser connected with each other through the refrigerant line.

The receiver drier may be connected with the air cooling type condenser through the refrigerant line and may be provided separately.

A heating body connected through the cooling line, into which a cooling fluid passing through the water cooling type condenser flows, may be disposed between the water cooling type condenser and the radiator.

The heating body may include an electrical power component, a motor, or a stack of an environmentally-friendly vehicle, and a water cooling type intercooler of an internal combustion engine vehicle.

A radiator for an internal combustion engine for cooling an internal combustion engine in an internal combustion engine vehicle may be provided between the radiator and the cooling fan.

An air conditioner according to another exemplary embodiment of the present invention for a vehicle comprises an expansion valve for expanding a liquid refrigerant, an evaporator for evaporating a refrigerant expanded through the expansion valve through heat exchange with air, and a compressor for receiving a gas state refrigerant from the

evaporator and compressing the gas state refrigerant, which are connected with each other through a refrigerant line.

The air conditioner includes a cooling means including a radiator disposed at front side of a vehicle, a cooling fan configured to send wind to the radiator, and a water pump connected through the cooling line and configured to circulate a cooling fluid. A water cooling type condenser is connected with the cooling line between the radiator and the water pump into which the cooling fluid flows, configured to condense a two-phase refrigerant, in which a superheated steam refrigerant, gas, and liquid are mixed from a compressor, through heat exchange with the cooling fluid, and disposed at one side of the radiator in a width direction of the vehicle. An air cooling type condenser is connected with the water cooling type condenser through a refrigerant line in series, into which the condensed refrigerant flows from the water cooling type condenser, disposed at front side of the radiator to condense the refrigerant through heat exchange with external air flowing in while driving and discharge the condensed refrigerant to a receiver drier. The air cooling type condenser receives a liquid refrigerant from which a gas refrigerant is separated while passing through the receiver drier to additionally condense the received liquid refrigerant through heat exchange with external air and discharge the condensed refrigerant to an expansion valve.

A heating body connected through the cooling line, into which a cooling fluid passing through the water cooling type condenser flows, may be disposed between the water cooling type condenser and the water pump.

The heating body may include an electrical power component, a motor, or a stack of an environmentally-friendly vehicle, and a water cooling type intercooler of an internal combustion engine vehicle.

The receiver drier may be separately provided at the water cooling type condenser and connected with the air cooling type condenser through the refrigerant line.

The condensers condensing the refrigerant are formed in the water cooling type and the air cooling type, respectively, to be applied together, so that the water cooling type condenser condenses the superheated steam refrigerant and the two-phase area refrigerant (the mixed refrigerant of gas and liquid). The air cooling type condenser secondarily condenses the liquid refrigerant passing through the receiver drier in a state where the two-phase area refrigerant is additionally condensed again, thereby increasing condensation performance of the refrigerant and improving general cooling performance.

The work load of the compressor by decreasing condensation pressure of the refrigerant can be decreased, thereby improving operation fuel efficiency.

The air cooling type condenser may be reduced in size by employing the water cooling type condenser, so that cooling performance is improved by increasing a passing air volume of the radiator and a temperature difference between external air and the liquid refrigerant, thereby being advantageous to form the sub cool of the refrigerant.

Improvement of the cooling performance of the radiator decreases the heat transfer amount of the cooling line, and thus, a water temperature of a circulated coolant may be decreased so that the coolant can be efficiently cooled without increasing capacity of the radiator and the cooling fan. Layout inside the narrow engine room is simplified so that space availability is improved, and weight and manufacturing cost are improved.

Further, when the present disclosure is applied to an environmentally-friendly vehicle, such as a fuel cell vehicle and an electric car, the heating body, such as an electrical power component, a motor, and a stack or an intercooler of an internal combustion engine vehicle, and the air conditioner refrigerant may be cooled by using the integrated radiator, thereby improving cooling performance and simplifying the configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings are for reference to describe the exemplary embodiments of the present disclosure and shall not be construed that the technical spirit of the present disclosure is limited to the accompanying drawings.

FIG. **1** is a block diagram of an air conditioner for a vehicle according to a first exemplary embodiment of the present disclosure.

FIG. **2** is a block diagram of an air conditioner for a vehicle according to a second exemplary embodiment of the present disclosure.

FIG. **3** is a block diagram of an air conditioner for a vehicle according to a third exemplary embodiment of the present disclosure.

FIG. **4** is a block diagram of an air conditioner for a vehicle according to a fourth exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, the present disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments are shown.

The exemplary embodiments described in the specification and the configuration illustrated in the drawings are simply the exemplary embodiments of the present disclosure, and do not represent all of the technical spirits of the present disclosure, and thus there are various equivalents and modification examples substitutable with the exemplary embodiment described in the present specification and the configuration illustrated in the drawing at the time of filing the present disclosure.

In addition, throughout the specification, unless explicitly described to the contrary, the word “comprise” and variations such as “comprises” or “comprising,” will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

FIG. **1** is a block diagram of an air conditioner for a vehicle according to a first exemplary embodiment of the present disclosure.

Referring to FIG. **1**, an air conditioner **100** for a vehicle improves cooling performance by reducing condensation pressure and increases condensation performance of a refrigerant by applying a water cooling type condenser using a coolant and an air cooling type condenser using external air together when the refrigerant is condensed.

To this end, the air conditioner **100** for the vehicle includes a cooling means, a water cooling type condenser **110**, and an air cooling type condenser **120**, and each constituent element will be described in more detail below.

The cooling means includes a radiator **102** disposed at front side of the vehicle and a cooling fan **104** for sending wind to the radiator **102**.

The cooling fan **104** is connected with a controller, which is not illustrated here, so that the air volume may be adjusted according to a state of the vehicle and temperature of coolant or cooling fluid.

The cooling means further includes a reservoir tank **106** connected with the radiator **102** through a cooling line **101** through which a cooling fluid flows to store the cooling fluid, and a water pump **108** provided on the cooling line **101** to circulate the cooling fluid.

The cooling fluid may include a coolant.

A radiator **103** for cooling an internal combustion engine for a vehicle may be further provided between the radiator **102** and the cooling fan **104**.

The radiator **103** for the internal combustion engine is connected with the internal combustion engine through a cooling line separated from the cooling line **102** included in the cooling means. The radiator **103** cools heat generated in the internal combustion engine and the heated cooling fluid with external air and through an operation of the cooling fan **104**, and supplies the cooled cooling fluid again.

The water cooling type condenser **110** is connected with the cooling line **101** between the radiator **102** and the reservoir tank **106** so that the cooling fluid flows in. A two-phase refrigerant in which superheated steam refrigerant, gas, and liquid are mixed flows in through a refrigerant line **111** through which the refrigerant flows from the compressor **116**. The water cooling type condenser **110** condenses the refrigerant through heat exchange between the coolant and the refrigerant.

The air conditioner means includes an expansion valve **112** for expanding the condensed refrigerant, an evaporator **114** for evaporating the expanded refrigerant through heat exchange between the expanded refrigerant and air, and a compressor **116** for compressing the refrigerant in an evaporated gas state, which are connected with each other through the refrigerant line **111**.

The air conditioner means condenses the compressed refrigerant discharged from the compressor **116** by making the refrigerant sequentially pass through the water cooling type condenser **110** and the air cooling type condenser **120**, which are connected with each other through the refrigerant line **111**.

The air cooling type condenser **120** is connected with the water cooling type condenser **110** in series through the refrigerant line **111**, so that the condensed liquid refrigerant flows into the air cooling type condenser **120** from the water cooling type condenser **110**.

The air cooling type condenser **120** is disposed at front side of the radiator **102** to condense the refrigerant through heat exchange with external air flowing in while driving and to discharge the condensed refrigerant to a receiver drier **130**.

The air cooling type condenser **120** receives only the liquid refrigerant from which the gas refrigerant is separated while passing through the receiver drier **130** and additionally condenses the received liquid refrigerant through heat exchange with external air to discharge the refrigerant to the expansion valve **112**.

The receiver drier **130**, which separates a gas state refrigerant left in the condensed refrigerant, may be connected with the air cooling type condenser **120** through the refrigerant line **111** and may be provided separately.

The receiver drier **130** separates a non-condensed gas refrigerant, which is included in the refrigerant condensed by the air cooling type condenser **120** and fails to be phase changed, from the liquid refrigerant and supplies the separated refrigerant to the air cooling type condenser **120** again.

The air cooling type condenser **120** receives a two-phase refrigerant (a mixed refrigerant of liquid and gas) first condensed through the water cooling type condenser **110**, condenses the received two-phase refrigerant through heat exchange with external air, and discharges the condensed refrigerant to the receiver drier **130**.

That is, the receiver drier **130** separates the non-condensed state gas refrigerant included in the introduced refrigerant from the liquid refrigerant, and makes only the liquid state refrigerant flow into the air cooling type condenser **120** through the refrigerant line **111**. In this case, the receiver drier **130** may also filters foreign materials included in the refrigerant.

Then, the air cooling type condenser **120** condenses the liquid state refrigerant from which the gas state refrigerant failing to be phase changed is separated by the receiver drier **130** through heat exchange with external air again, thereby improving condensation efficiency of the refrigerant.

The water cooling type condenser **110** cools the refrigerant by using coolant having a larger heat transfer coefficient than that of external air, thereby decreasing condensation pressure inside the water cooling type condenser **110**.

The air cooling type condenser **120** first condenses the refrigerant condensed while passing through the water cooling type condenser **110** through heat exchange with external air, makes the condensed refrigerant flow into the receiver drier **130**, and receives only the liquid state refrigerant again. The air cooling type condenser **120** then cools the received liquid state refrigerant by using external air again in a state where the non-condensed gas refrigerant included in the liquid refrigerant is separated, so that the temperature difference between the external air and the refrigerant is increased, thereby being advantageous to form sub cool and decreasing a heat transfer amount of the cooling line **101**.

That is, the air conditioner **100** for the vehicle employs the water cooling type condenser **110** and the air cooling type condenser **120** together to complement the drawbacks according to each type by efficiently using the condensation pressure decrease, which is the advantage of the water cooling type, and the advantageous forming of the sub cool, which is the advantage of the air cooling type, thereby improving general cooling performance of the air conditioner **100**.

The condensers **110** and **120** condensing the refrigerant are formed in the water cooling type and the air cooling type, respectively, to be applied together, so that the water cooling type condenser **110** condenses the superheated steam refrigerant and the two-phase area refrigerant (the mixed refrigerant of gas and liquid). The air cooling type condenser **120** secondarily condenses the liquid refrigerant passing through the receiver drier **130** in a state where the two-phase area refrigerant is additionally condensed again, thereby increasing condensation performance of the refrigerant and improving general cooling performance.

The work load of the compressor by decreasing the condensation pressure of the refrigerant is decreased, thereby improving operation fuel efficiency.

The air cooling type condenser **120** may be reduced in size by employing the water cooling type condenser **110**. Cooling performance can be improved by increasing a passing air volume of the radiator **102** and simultaneously a temperature difference between external air and the liquid refrigerant can be increased, thereby being advantageous to form the sub cool of the refrigerant.

Further, the improvement of the cooling performance of the radiator **102** decreases the heat transfer amount of the cooling line **101**, and water temperature of circulated coolant may be decreased, thus cooling the coolant without increasing a capacity of the radiator **102** and the cooling fan **104**. Layout inside the narrow engine room is simplified, thus improving space availability, weight, and manufacturing cost.

FIG. **2** is a block diagram of an air conditioner for a vehicle according to a second exemplary embodiment of the present disclosure.

Referring to FIG. **2**, an air conditioner **200** for a vehicle, which is applied to an environmentally-friendly vehicle such as a fuel cell vehicle, an electric vehicle, and the like, improves cooling performance by reducing condensation pressure and condensation performance of refrigerant by employing the water cooling type condenser using a coolant and the air cooling type condenser using external air together when a refrigerant is condensed.

The air conditioner **200** for the vehicle according to the second exemplary embodiment of the present disclosure includes a cooling means, a first condenser **210**, and a second condenser **220**.

The cooling means includes a radiator **202** disposed at front side of the vehicle, a cooling fan **204** for sending wind to the radiator **202**, a reservoir tank **206** connected with the radiator **202** through a cooling line **201** through which a cooling fluid flows to store the cooling fluid, and a water pump **208** disposed on the cooling line **201** to circulate the cooling fluid.

Here, the cooling fan **204** is connected with a controller, which is not illustrated here, so that air volume may be adjusted according to a state of the vehicle. Temperature of the refrigerant or the cooling fluid and the cooling fluid may include a coolant.

The water cooling type condenser **210** is connected with the cooling line **201** between the radiator **202** and the reservoir tank **206** so that the cooling fluid flows in. A two-phase refrigerant in which a superheated steam refrigerant, and gas, liquid are mixed flows in a refrigerant line **211** through which the refrigerant flows from the compressor **216**, so that the water cooling type condenser **210** first condenses the refrigerant through heat exchange between the coolant and the refrigerant.

The air conditioner means includes an expansion valve **212** for expanding the condensed refrigerant, an evaporator **214** for evaporating the expanded refrigerant through heat exchange between the expanded refrigerant and air, and a compressor **216** for compressing the refrigerant in an evaporated gas state, which are connected with each other through the refrigerant line **211**.

The air conditioner means condenses the compressed refrigerant discharged from the compressor **216** by making the refrigerant sequentially pass through the water cooling type condenser **210** and the air cooling type condenser **220**, which are connected with each other through the refrigerant line **211**.

The air cooling type condenser **220** is connected with the water cooling type condenser **210** in series through the refrigerant line **211**, so that the condensed liquid refrigerant flow in from the water cooling type condenser **210**. The air cooling type condenser **220** is disposed at front side of the radiator **202** to condense the refrigerant through heat exchange with external air flowing in while driving and discharge the condensed refrigerant to a receiver drier **230**.

The air cooling type condenser **220** receives only the liquid refrigerant from which the gas refrigerant is separated while passing through the receiver drier **230** and additionally condenses the received liquid refrigerant through heat exchange with external air to discharge the refrigerant to the expansion valve **212**.

Here, the receiver drier **230**, which separates a gas state refrigerant left in the condensed refrigerant, may be connected with the air cooling type condenser **220** through the refrigerant line **211**, and may be separately provided. The receiver drier **230** separates a non-condensed gas refrigerant, which is included in the refrigerant condensed by the air cooling type condenser **220** and fails to be phase changed, from the liquid refrigerant and supplies the separated refrigerant to the air cooling type condenser **220** again.

A heating body **240** connected through the cooling line **201**, into which the coolant passing through the water cooling type condenser **210** flows, may be disposed between the water cooling type condenser **210** and the radiator **202**. The heating body **240** may include an electrical power component, a motor, or a stack applied to an environmentally-friendly vehicle, such as a fuel cell vehicle and an electric vehicle, and a water cooling type intercooler applied to an internal combustion engine vehicle.

That is, heat generated from the heating body **240** is cooled through heat exchange with the coolant which circulates in the cooling line **201** through an operation of the water pump **208** and discharged from the water cooling type condenser **210**.

Accordingly, the coolant cools the heating body **240**, flows into the radiator **202** again, and is cooled while circulating the cooling line **201** through the operation of the water pump **208** in a heated state. The coolant is stored in the reservoir tank **206** through the operation of the water pump **208** and flown into the water cooling type condenser **210** to be heat exchanged with the refrigerant, and the operation is repeated.

The air cooling type condenser **220** receives the first condensed two-phase refrigerant (a mixed refrigerant of a liquid and gas) through the water cooling type condenser **210**, condenses the two-phase refrigerant through heat exchange with external air, and discharges the condensed refrigerant to the receiver drier **230**.

The receiver drier **230** separates the non-condensed state gas refrigerant included in the flowing-in refrigerant from the liquid refrigerant, and makes only the liquid state refrigerant flow into the air cooling type condenser **220** through the refrigerant line **211** again. In this case, the receiver drier **230** may also filter foreign materials included in the refrigerant.

Then, the air cooling type condenser **220** condenses the liquid state refrigerant from which the gas state refrigerant failing to be phase changed is separated by the receiver drier **230** through heat exchange with external air again, thereby improving condensation efficiency of the refrigerant.

In the air conditioner **200**, the water cooling type condenser **210** cools the refrigerant by using the coolant having a larger heat transfer coefficient than that of external air, thereby decreasing condensation pressure inside the water cooling type condenser **210**.

Further, the air cooling type condenser **220** first condenses the refrigerant condensed while passing through the water cooling type condenser **210** through heat exchange with external air, makes the condensed refrigerant flow into the receiver drier **230**, receives only the liquid state refrigerant, and cools the received liquid state refrigerant by using external air again in a state where the non-condensed gas refrigerant included in the liquid refrigerant is separated. A temperature difference between the external air and the refrigerant can be increased, thereby being advantageous to form sub cool and decreasing a heat transfer amount of the cooling line **201**.

The air conditioner **200** for the vehicle employs the water cooling type condenser **210** and the air cooling type condenser **220** together to complement the drawbacks according to each type by efficiently using the condensation pressure decrease, which is the advantage of the water cooling type, and forming of the sub cool, which is the advantage of the air cooling type, thereby improving general cooling performance of the air conditioner **200**.

The condensers **210** and **220** condensing the refrigerant are formed in the water cooling type and the air cooling type, respectively, to be applied together. The water cooling type condenser **210** condenses the superheated steam refrigerant and the two-phase area refrigerant (the mixed refrigerant of gas and liquid). The air cooling type condenser **220** secondarily condenses the liquid refrigerant passing through the receiver drier **230** in a state where the two-phase area refrigerant is additionally condensed again, thereby increasing condensation performance of the refrigerant and improving general cooling performance.

The work load of the compressor is decreased by decreasing the condensation pressure of the refrigerant, thereby improving operation fuel efficiency.

The air cooling type condenser **220** may be reduced in size by employing the water cooling type condenser **210**, so that cooling performance is improved by increasing air volume of the radiator **202**. The temperature difference between external air and the liquid refrigerant can be increased simultaneously, thereby being advantageous to form the sub cool of the refrigerant.

The improvement of the cooling performance of the radiator **202** decreases the heat transfer amount of the cooling line **201**. Water temperature of the circulated coolant may be decreased to efficiently cool the coolant without increasing a capacity of the radiator **202** and the cooling fan **204**, simplify layout inside the narrow engine room so that space availability is improved, and decrease weight and manufacturing cost.

Further, when the present disclosure is applied to an environmentally-friendly vehicle, such as a fuel cell vehicle and an electric car, the heating body **240**, such as the electrical power component, the motor, and the stack or the intercooler of the internal combustion engine vehicle, and the air conditioner refrigerant may be cooled by using the one integrated radiator **202**, thereby improving cooling performance and simplifying the configuration.

FIG. **3** is a block diagram of an air conditioner system for a vehicle according to a third exemplary embodiment of the present disclosure.

Referring to FIG. **3**, an air conditioner **300** for a vehicle according to the third exemplary embodiment of the present disclosure improves cooling performance by reducing condensation pressure and increases condensation performance of a refrigerant by applying a water cooling type condenser using a coolant and an air cooling type condenser using external air together when the refrigerant is condensed.

The air conditioner **300** for the vehicle includes an expansion valve **312** for expanding a liquid refrigerant, an evaporator **314** for evaporating the refrigerant expanded through the expansion valve **312** through heat exchange between the expanded refrigerant and air, and a compressor **316** for receiving the refrigerant in a gas state from the evaporator **312** and compressing the received refrigerant, which are connected with each other through a refrigerant line **311**.

The air conditioner **300** for the vehicle further includes a cooling means, a water cooling type condenser **310**, and an air cooling type condenser **320**, and each constituent element will be described in more detail below.

The cooling means includes a radiator **302** provided at front side of the vehicle, a cooling fan **304** for sending wind to the radiator **302**, and a water pump **306** connected with the radiator **302** through the cooling line **301** to circulate the cooling fluid.

Here, the cooling fan **304** is connected with a controller, which is not illustrated here, so that air volume may be adjusted according to a state of the vehicle and the temperature of the refrigerant or the cooling fluid The cooling fluid may include a coolant.

The water cooling type condenser **310** is connected with the cooling line **301** between the radiator **302** and the water pump **306** so that the cooling fluid inflows. A two-phase refrigerant in which a superheated steam refrigerant, gas, and, liquid are mixed inflows through a refrigerant line **311** through which the refrigerant flow from the condenser **316**, so that the water cooling type condenser **310** condenses the refrigerant through heat exchange between the coolant and the refrigerant.

The water cooling type condenser **310** is disposed at one side of the radiator **302** in a width direction of the vehicle.

The air cooling type condenser **320** is connected with the water cooling type condenser **310** in series through the refrigerant line **311**, so that the condensed liquid refrigerant inflows from the water cooling type condenser **310**.

The air cooling type condenser **320** is disposed at front side of the radiator **302** to condense the refrigerant through heat exchange with external air flowing in while driving and discharge the condensed refrigerant to a receiver drier **330**.

The air cooling type condenser **320** receives only the liquid refrigerant from which the gas refrigerant is separated while passing through the receiver drier **330** and additionally condenses the received liquid refrigerant through heat exchange with external air to discharge the refrigerant to the expansion valve **312**.

The receiver drier **330**, which separates a gas state refrigerant left in the condensed refrigerant, may be connected with the air cooling type condenser **320** through the refrigerant line **311**, and may be separately provided. The receiver drier **330** separates a non-condensed gas refrigerant, which is included in the refrigerant condensed by the air cooling type condenser **320** and fails to be phase changed, from the liquid refrigerant and supplies the separated refrigerant to the air cooling type condenser **320** again.

That is, the receiver drier **330** separates a non-condensed gas refrigerant, which is included in the refrigerant condensed by the air cooling type condenser **320** and fails to be phase changed, from the liquid refrigerant and supplies the separated refrigerant to the air cooling type condenser **320** again.

Further, the air cooling type condenser **320** receives a two-phase refrigerant (a mixed refrigerant of a liquid and gas) first condensed through the water cooling type condenser **310**, condenses the received two-phase refrigerant through heat exchange with external air, and discharges the condensed refrigerant to the receiver drier **330**.

The receiver drier **330** separates the non-condensed state gas refrigerant included in the introduced refrigerant from the liquid refrigerant, and makes only the liquid state refrigerant flow into the air cooling type condenser **320** through the refrigerant line **311** again.

In this case, the receiver drier **330** may also filter foreign materials included in the refrigerant.

Then, the air cooling type condenser **320** condenses the liquid state refrigerant from which the gas state refrigerant failing to be phase changed is separated by the receiver drier **330** through heat exchange with external air again, thereby improving condensation efficiency of the refrigerant.

The water cooling type condenser **310** cools the refrigerant by using a coolant having a larger heat transfer coefficient than that of external air, thereby decreasing condensation pressure inside the water cooling type condenser **310**.

Further, the air cooling type condenser **320** first condenses the refrigerant condensed while passing through the water cooling type condenser **310** through heat exchange with external air, makes the condensed refrigerant flow into the receiver drier **330**, and receives only the liquid state refrigerant again and cools the received liquid state refrigerant by using external air again in a state where the non-condensed gas refrigerant included in the liquid refrigerant is separated. A temperature difference between the external air and the refrigerant can be increased, thereby being advantageous to form sub cool and decreasing a heat transfer amount of the cooling line **301**.

The air conditioner **300** employs the water cooling type condenser **310** and the air cooling type condenser **320** together to complement the drawbacks according to each type by efficiently using the condensation pressure decrease, which is the advantage of the water cooling type, and the advantageous forming of the sub cool, which is the advantage of the air cooling type, thereby improving general cooling performance of the air conditioner **300**.

The condensers **310** and **320** condensing the refrigerant are formed in the water cooling type and the air cooling type, respectively, to be applied together. The water cooling type condenser **310** condenses the superheated steam refrigerant and the two-phase area refrigerant (the mixed refrigerant of gas and liquid), and the air cooling type condenser **320** secondarily condenses the liquid refrigerant passing through the receiver drier **330** in a state where the two-phase area refrigerant is additionally condensed again, thereby increasing condensation performance of the refrigerant and improving general cooling performance.

The work load of the compressor can be decreased by decreasing the condensation pressure of the refrigerant, thereby improving operation fuel efficiency.

The air cooling type condenser **320** may be reduced in size by employing the water cooling type condenser **310**, so that cooling performance can be improved by increasing a passing air volume of the radiator **302**, and simultaneously a temperature difference between external air and the liquid refrigerant can be increased, thereby being advantageous to form the sub cool of the refrigerant.

The improvement of the cooling performance of the radiator **302** decreases the heat transfer amount of the cooling line **301**. Water temperature of a circulated coolant may be decreased to efficiently cool the coolant can be efficiently cooled without increasing a capacity of the radiator **302** and the cooling fan **304**, simplify layout inside the narrow engine room so that space availability is improved, and decrease weight and manufacturing cost.

FIG. **4** is a block diagram of an air conditioner for a vehicle according to a fourth exemplary embodiment of the present disclosure.

Referring to FIG. **4**, an air conditioner system **400** for a vehicle, which is applied to a fuel cell vehicle, an electric vehicle, and the like, which are an environmentally-friendly vehicles, improves cooling performance by reducing condensation pressure and condensation performance of refrigerant by employing the water cooling type condenser using a coolant and the air cooling type condenser using external air together when a refrigerant is condensed.

The air conditioner **400** for the vehicle includes an expansion valve **412** for expanding a liquid refrigerant, an evaporator **414** for evaporating the refrigerant expanded through the expansion valve **412** through heat exchange between the expanded refrigerant and air, and a compressor **416** for receiving the refrigerant in a gas state from the evaporator **412** and compressing the received refrigerant, which are connected with each other through a refrigerant line **411**.

Here, the air conditioner **400** for the vehicle further includes a cooling means, a water cooling type condenser **410**, and an air cooling type condenser **420**, and each constituent element will be described in more detail below.

The cooling means includes a radiator **402** provided at a front side of the vehicle, a cooling fan **404** for sending wind to the radiator **402**, and a water pump **406** connected with the radiator **402** through the cooling line **401** to circulate the cooling fluid.

Here, the cooling fan **404** is connected with a controller, which is not illustrated here, so that an air volume may be adjusted according to a state of the vehicle, and a temperature of the refrigerant or the cooling fluid. The cooling fluid may include a coolant.

The water cooling type condenser **410** is connected with the cooling line **401** between the radiator **402** and the water pump **406** so that the cooling fluid inflows. A two-phase refrigerant in which a superheated steam refrigerant, gas, and liquid are mixed inflows through a refrigerant line **411** through which the refrigerant flow from the compressor **416** of an air conditioner means, so that the water cooling type condenser **410** first condenses the refrigerant through heat exchange between the coolant and the refrigerant.

The water cooling type condenser **410** is positioned at one side of the radiator **402** in a width direction of the vehicle.

The air cooling type condenser **420** is connected with the water cooling type condenser **410** in series through the refrigerant line **411**, so that the condensed liquid refrigerant inflows from the water cooling type condenser **410**.

The air cooling type condenser **420** is disposed at a front side of the radiator **402** to condense the refrigerant through heat exchange with external air flowing in while driving and discharge the condensed refrigerant to a receiver drier **430**.

Further, the air cooling type condenser **420** receives only the liquid refrigerant from which the gas refrigerant is separated while passing through the receiver drier **430** and additionally condenses the received liquid refrigerant through heat exchange with external air to discharge the refrigerant to the expansion valve **412**.

Here, the receiver drier **430**, which separates a gas state refrigerant left in the condensed refrigerant, may be connected with the air cooling type condenser **420** through the refrigerant line **411**, and may be separately provided.

The receiver drier **430** separates a non-condensed gas refrigerant, which is included in the refrigerant condensed by the air cooling type condenser **420** and fails to be phase changed, from the liquid refrigerant and supplies the separated refrigerant to the air cooling type condenser **420**.

A heating body **440** connected through the cooling line **401**, into which the coolant passing through the water cooling type condenser **410** flows, may be disposed between the water cooling type condenser **410** and the radiator **402**.

The heating body **440** may include an electrical power component, a motor, or a stack applied to an environmentally-friendly vehicle, such as a fuel cell vehicle and an electric vehicle, and a water cooling type intercooler applied to an internal combustion engine vehicle.

Heat generated from the heating body **440** is cooled through heat exchange with the coolant which circulates the cooling line **401** through an operation of the water pump **406** and is discharged from the water cooling type condenser **410**.

Accordingly, a coolant cools the heating body **440**, flows into the radiator **402** again while circulating the cooling line **401** through the operation of the water pump **406** in a heated state, flows into the water cooling type condenser **410** through the operation of the water pump **406** to be heat exchanged with the refrigerant, and the operation is repeatedly performed.

The air cooling type condenser **420** receives the first condensed two-phase refrigerant (a mixed refrigerant of a liquid and gas) through the water cooling type condenser **410**, condenses the two-phase refrigerant through heat exchange with external air, and discharges the condensed refrigerant to the receiver drier **430**.

The receiver drier **430** separates the non-condensed state gas refrigerant included in the flowing-in refrigerant from the liquid refrigerant and makes only the liquid state refrigerant flow into the air cooling type condenser **420** through the refrigerant line **411** again.

In this case, the receiver drier **430** may also filter foreign materials included in the refrigerant.

Then, the air cooling type condenser **420** condenses the liquid state refrigerant from which the gas state refrigerant failing to be phase changed is separated by the receiver drier **430** through heat exchange with external air again, thereby improving condensation efficiency of the refrigerant.

The water cooling type condenser **410** cools the refrigerant by using the coolant having a larger heat transfer coefficient than that of external air, thereby decreasing condensation pressure inside the water cooling type condenser **410**.

Further, the air cooling type condenser **420** first condenses the refrigerant condensed while passing through the water cooling type condenser **410** through heat exchange with external air, makes the condensed refrigerant flow into the receiver drier **430**, receives only the liquid state refrigerant again, and cools the received liquid state refrigerant by using external air in a state where the non-condensed gas refrigerant included in the liquid refrigerant is separated. The temperature difference between the external air and the refrigerant can be increased, thereby being advantageous to form sub cool and decreasing a heat transfer amount of the cooling line **401**.

That is, the air conditioner **400** employs the water cooling type condenser **410** and the air cooling type condenser **420** together to complement the drawbacks according to each type by efficiently using the condensation pressure decrease, which is the advantage of the water cooling type, and the advantageous forming of the sub cool, which is the advantage of the air cooling type, thereby improving general cooling performance of the air conditioner **400**.

The condensers **410** and **420** condensing the refrigerant are formed in the water cooling type and the air cooling type, respectively, to be applied together. The water cooling type condenser **410** condenses the superheated steam refrigerant and the two-phase area refrigerant (the mixed refrigerant of gas and the liquid), and the air cooling type condenser **420** secondarily condenses the liquid refrigerant passing through the receiver drier **430** in a state where the two-phase area refrigerant is additionally condensed again, thereby increasing condensation performance of the refrigerant and improving general cooling performance.

The work load of the compressor can be decreased by decreasing the condensation pressure of the refrigerant, thereby improving operation fuel efficiency.

The air cooling type condenser **420** may be reduced in size by employing the water cooling type condenser **410** to improve cooling performance by increasing a passing air volume of the radiator **402** and simultaneously increase a temperature difference between external air and the liquid refrigerant, thereby being advantageous to form the sub cool of the refrigerant.

The improvement of the cooling performance of the radiator **402** decreases the heat transfer amount of the cooling line **401**. Water temperature of a circulated coolant may be decreased to efficiently cool the coolant without increasing a capacity of the radiator **402** and the cooling fan **404**, simplify layout inside the narrow engine room so that space availability is improved, and decrease weight and manufacturing cost.

Further, when the present disclosure is applied to an environmentally-friendly vehicle, such as a fuel cell vehicle and an electric car, the heating body **440**, such as the electrical power component, the motor, and the stack or the intercooler of the internal combustion engine vehicle, and the air conditioner refrigerant may be cooled by using the one integrated radiator **402**, thereby improving cooling performance and simplifying the configuration.

While the present disclosure has been described in connection with what is presently considered to be practical exemplary embodiments, the inventive concept is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. An air conditioning system for a vehicle, comprising:

a cooler including: a first radiator; a cooling fan configured to send air flow to the first radiator; a reservoir tank communicating with the first radiator via a cooling line and storing a cooling fluid; and a water pump disposed on the cooling line between the reservoir tank and the first radiator to circulate the cooling fluid;

a water-cooled condenser connected to the cooling line between the first radiator and the reservoir tank so that the cooling fluid flows into the first radiator, the water cooling condenser condensing superheated steam and a two-phase refrigerant, which includes gas and liquid via heat exchange with the cooling fluid; and

an air-cooled condenser communicating with the water-cooled condenser via a refrigerant line in series, so that the condensed refrigerant flows from the water-cooled condenser into the air-cooled condenser through the refrigerant line,

wherein the air-cooled condenser is disposed at one side of the first radiator to condense the refrigerant via heat exchange with external air as the vehicle travels and discharge the condensed refrigerant to a receiver drier,

wherein the air-cooled condenser receives only a liquid refrigerant as the liquid refrigerant passes through the receiver drier to additionally condense the received liquid refrigerant by heat exchange with external air and to discharge the condensed refrigerant,

wherein the receiver drier communicates with the air-cooled condenser via the refrigerant line, and

wherein the refrigerant flows sequentially from the water-cooled condenser directly to the air-cooled condenser, from the air-cooled condenser directly to the receiver drier, and then from the receiver drier directly to the air-cooled condenser.

2. The air conditioning system of claim **1**, further comprising:

an air conditioner including: an expansion valve for expanding the condensed refrigerant; an evaporator for evaporating the expanded refrigerant by heat exchange with external air; and a compressor for compressing the evaporated gas state refrigerant,

wherein the expansion valve and the evaporator communicate with each other via the refrigerant line, and

wherein the air conditioner condenses the compressed refrigerant that is discharged from the compressor by allowing the discharged refrigerant to pass sequentially through the water-cooled condenser and the air-cooled condenser.

3. The air conditioning system of claim **1**, wherein:

a heating body connected through the cooling line, into which the cooling fluid passing through the water cooled condenser flows, is disposed between the water cooled condenser and the first radiator.

4. The air conditioning system of claim **3**, wherein:

the heating body includes an electrical power component, a motor, or a stack of an environmentally-friendly vehicle, and a water-cooled intercooler of an internal combustion engine vehicle.

5. The air conditioning system of claim **1**, further comprising:

a second radiator disposed between the first radiator and the cooling fan and configured to cool an internal combustion engine.

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